Crowd Sourcing Medical Data Collection Using Medical Students

Human Research Program
Exploration Medical Capability Element

February 7, 2022

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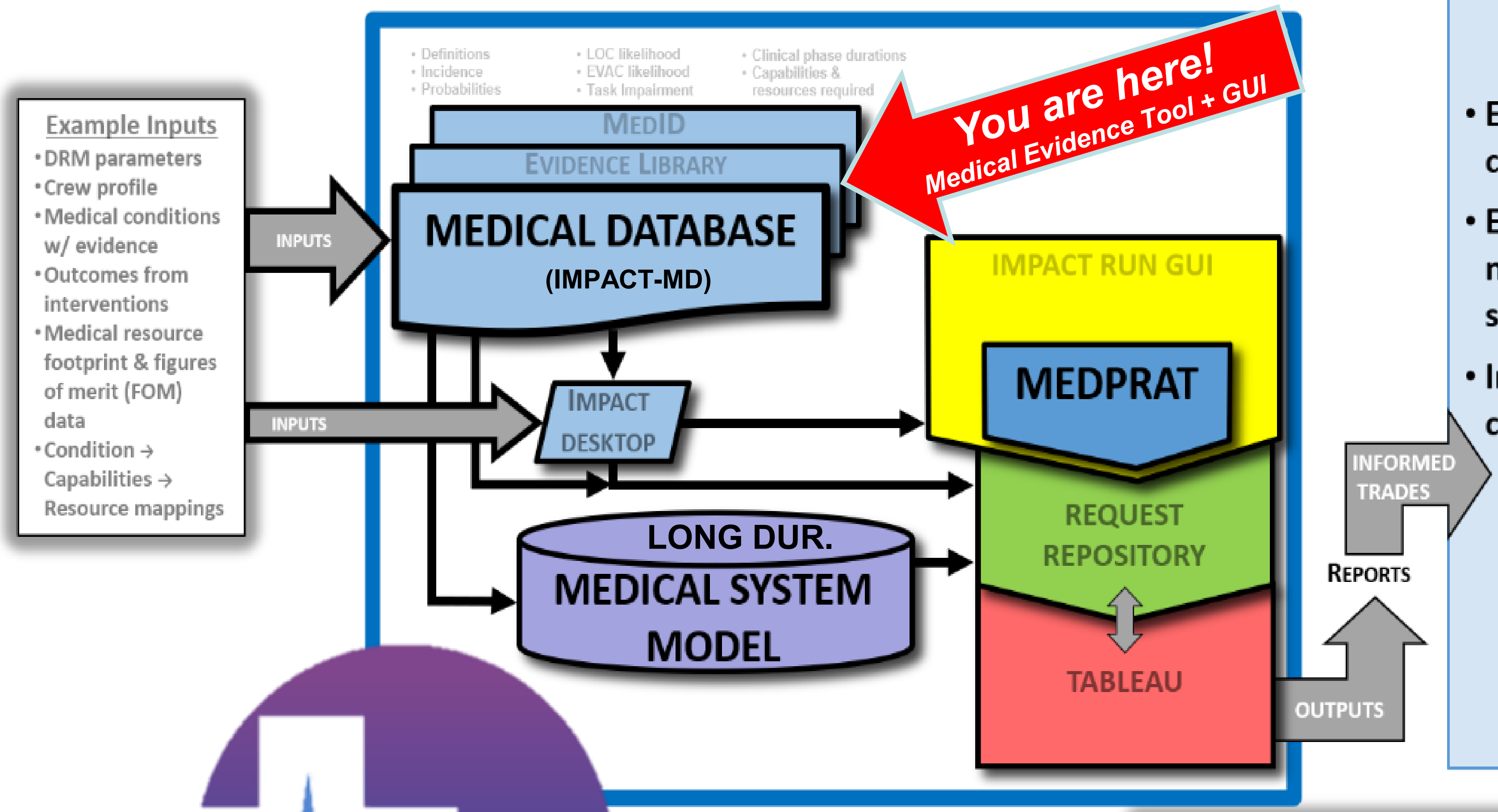
"Expanding the Boundaries of Space Medicine and Technology"

Agenda

- Overview
- IMPACT
- Integrated Medical Evidence Database (IMED)
- CU Students, Faculty and a Space Medicine Curriculum
- Asynchronous Collaboration
- Evidence Library development: Incidence and Outcome data
- Summary and Citation

IMPACT: A suite of tools working together



IMPACT v1.0

- Extensible architecture-based, multi-component medical planning system
- Empowers complex layered analysis of multivariate internal & external trade space issues
- Informs key operational decisions for customers:
  - **EXTERNAL**
    - HSRB
    - SD
    - ARTEMIS
    - ORION
    - GATEWAY
  - **INTERNAL**
    - IMPACT TEAM

Example Outputs
- Medical risks
- Optimized medical set contents
- Medical conditions treated/untreated
- Mission requirements met/unmet

IMPACT v1.0

IMPACT: Informing Mission Planning via Analysis of Complex Tradespaces

Evidence Library

- **122 medical conditions…**
  - What's the chance that one occurs? (incidence, prevalence)
  - What would be the best possible outcome?
  - What would be the worst possible outcome?
  - What if we didn't have the Rx to treat?
  - What's the likelihood the mission will need to be canceled?
  - How long is the astronaut going to be out of commission?
  - What are the chances an astronaut would die?
  - How good is the data backing up these answers?!

2021: Three 4-week medical student electives

- **IDPT 8059- *credentialed course***
- **University of Colorado School of Medicine**
  - Visiting students included [VSAS]
  - 20-25 students per elective

University of Colorado
SECTION OF WILDERNESS AND ENVIRONMENTAL MEDICINE
DEPARTMENT OF EMERGENCY MEDICINE

- **Space Medicine 101: didactics & learning Scenarios (25%)**
- **Evidence Library search didactics and precepting (75%)**
- **Delivered in ½ day blocks**
- **Each student expected to perform 1-2 *Rapid Systematic Reviews***

Faculty

- **ExMC Clinicians [2]**
- **ExMC Epidemiologist [1]**
- **University of Colorado**
  - Wilderness Medicine/Emergency Medicine Physician [1]
  - Research Library Scientist [1]
  - Biostatistician/EBM Professors [3]
  - Course Administrative support [1]

University of Colorado
SECTION OF WILDERNESS AND ENVIRONMENTAL MEDICINE
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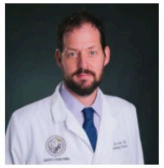


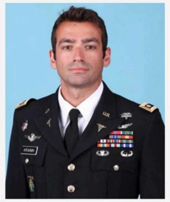
Jay Lemery, MD, FACEP, FAWM
Section Chief Wilderness & Environmental Medicine Section
Professor in Emergency Medicine

Dana Levin, MD, MPH
Assistant Professor in Emergency Medicine
Columbia University Vagelos School of Medicine
Co-Founder, Space and Extreme Environmental Medicine Program

Tianjing Li, MD, MHS, PhD
Associate Professor in the Department of Ophthalmology at University of Colorado Denver with a secondary appointment in the Department of Epidemiology at University of Colorado School of Public Health

Christi Piper, MLIS, AHIP
Librarian
Senior Instructor, Strauss Health Sciences Library

Ben Krainin, MD
Clinical Instructor, Emergency Medicine



Medical School:
- MD, Georgetown University School of Medicine (2014)

Professional Memberships
- American College of Emergency Physicians, Fellow

Practice Locations
University of Colorado Hospital (UCH)
12605 E. 16th Ave
Aurora, CO 80045
720-848-0000

Hospital Affiliation
- University of Colorado Hospital

Specialty Information
Specialties
- Emergency Medicine, Board Certification (2018)

Angela Lee-Winn, PhD
Assistant Professor in Epidemiology. Colora
School of Public Health

Alison Abraham, PhD MS MHS
Associate Professor in Epidemiology
Ophthalmology

Adrienne T. Hoyt, MS, MPH, MALA, MALS
NASA Exploration Medical Capability Element (ExMC)/Human Research Program Epidemiologist

Meagan Rivers

Meagan Rivers is an administrator for the Wilderness and Environmental Medicine section at the University of Colorado School of Medicine. She graduated from Canisius College in 2010 with a BA in Sociology. Before the University of Colorado, she worked at a local Catholic Church, as well as a website design and digital marketing boutique agency.

Space Medicine 101 [25% curriculum]

- **Lectures**
- **Mars *Ares 1* practicums**
  - –e-learning app *Articulate*, with 8 filmed scenarios at the Mars Desert Research Station

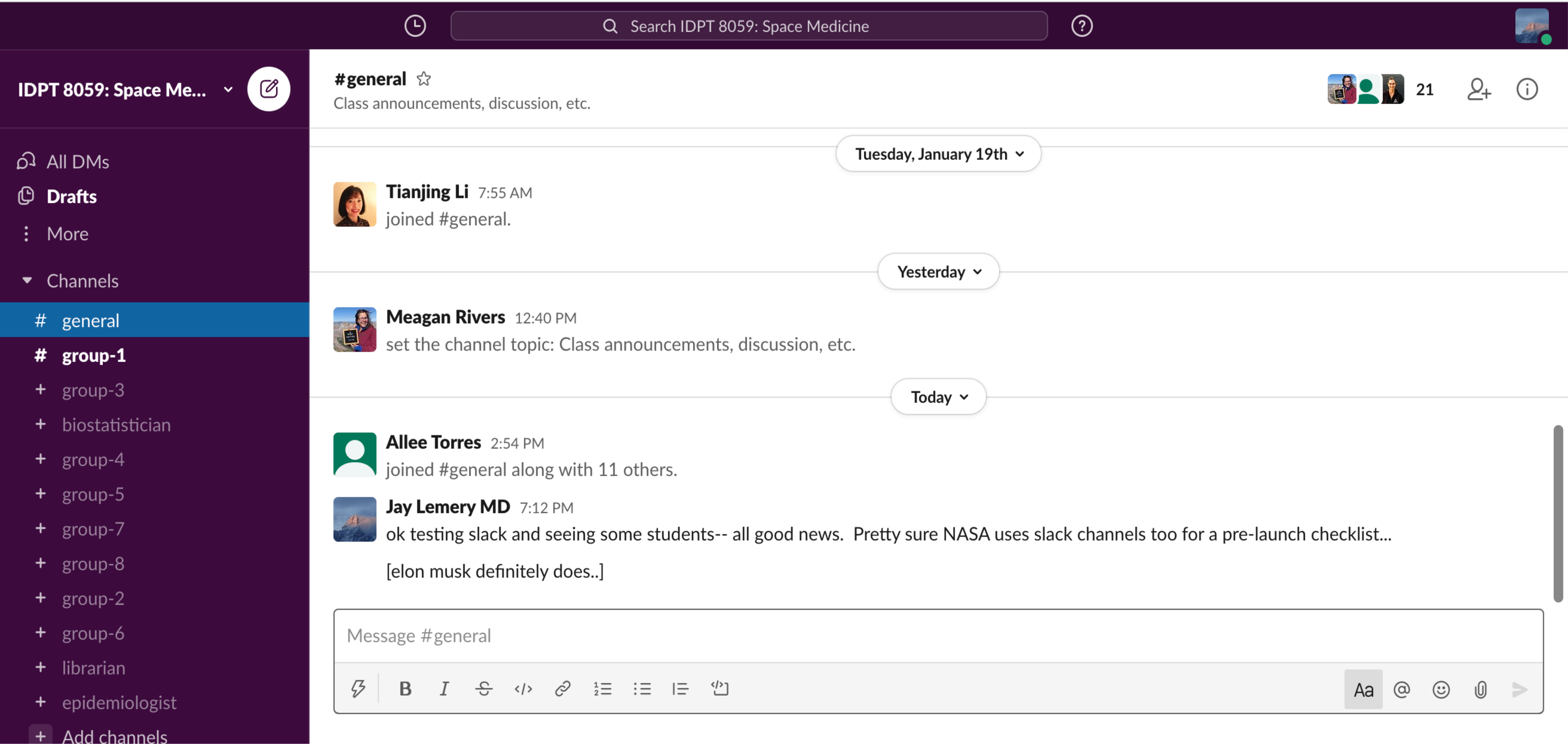
Collaborators

- Allie Anderson PhD: *Space Suits--Engineering principles & Human Factors Engineering*
- Erik Antonsen MD PhD: *Design Medicine*
- Mike Barratt MD, Former astronaut: *Cases in Space Medicine/Forces & Vibration*
- Dani Carroll MD, NASA/TRISH researcher, USAF: *Spatial Disorientation*
- Rick Cole MD MPH: *Medical Operations*
- Ben Easter MD MBA, NASA ExMC Deputy Element Scientist: *Medical Kit Design*
- Dave Hilmers MD, MPH, Former astronaut: *TBD*
- Kris Lehnhardt MD, NASA ExMC Element Scientist: *Intro to Space Medicine & ExMC basics*
- Jay Lemery MD: *Analogues: Polar Medicine*
- Dana Levin MD MPH: *Space Radiation*
- Eric Kerstman MD: Space Adaptation
- Ben Krainin MD: Atmospheric & Altitude Physiology and Gas Mixtures
- Amy Kreykes MD MPH: Structural Physiology and Countermeasures
- James Picano: Psychological Factors in Human Spaceflight
- Ed Powers MD MS: Education in Space Medicine
- Elaine Reno MD: Analogues: Wilderness Medicine
- Matt Rogers MD: Analogues: NASA HERA (Human Exploration Research Analog)
- Bob Sanders MD: Medical Director, NASA Neutral Buoyancy Lab: Pressure Physiology
- Rahul Suresh MD MPH: Cardiovascular Physiology
- Chris Zahner MD: Engineering & Aerospace Medicine- Flight Control Operations

Supported by Canvas platform

- All Documents
- Lecture Schedule
- Faculty Intro Lectures
- Daily Schedule
- Faculty Office Hour availability
- Zoom links
- Contact info
- Tutorial Videos

Asynchronous communication via Slack
#general/ #groups [*aka Pods*]/ #experts (*how to videos posted on canvas)*



Students assigned 90 of 122 medical conditions

ICL25	CHOKING/OBSTRUCTED AIRWAY
ICL26	CHOLELITHIASIS_BILIARY COLIC, ACUTE
ICL27	COLD INJURY - CHILBLAINS/FROSTBITE
ICL35	DIVERTICULITIS, ACUTE
ICL37	EBULISM
ICL62	GRAVITY WELL - ORTHOSTATIC INTOLERANC
ICL75	PANCREATITIS, ACUTE
ICL79	REACTIVE AIRWAY
ICL80	RESPIRATORY FAILURE
ICL83	SEIZURES
ICL84	SEPSIS
ICL85	SHOCK - CARDIOGENIC
ICL90	SMALL BOWEL OBSTRUCTION
ICL106	SUDDEN CARDIAC ARREST
ICL110	Toxic Inhalation Exposure
ICL111	Toxic Inhalation Exposure – Combustion Product
ICL112	TRAUMA - ABDOMINAL INJURY (BLUNT)
ICL113	TRAUMA - CHEST INJURY (BLUNT)
ICL114	TRAUMA - MINOR HEAD
ICL115	TRAUMA - SEVERE HEAD
ICL116	TRAUMATIC HYPOVOLEMIC SHOCK
ICL119	VENOUS THROMBOEMBOLISM

- **Each condition pre-determined best- and worst-case definition**
- **Example:**

EPISTAXIS

Best case: ***An anterior nosebleed that resolves with minimal or no treatment.***

Worst case: ***A posterior nosebleed that requires nasal packing and possibly surgical treatment.***

Evidence collection- elements needed

- **Incidence**
  - Space
  - Analogue
  - Terrestrial
  - Condition definition
    - % best case
    - % worst case

- **Treatment & Outcomes**
  - Time duration of treatment [*clinical phase II*]
  - Return to Definitive Care [RTDC]
  - Loss of Crew Life [LOCL]

Data integration

- **Correlation with *other clinical phase durations* and *resources***
  - *Clinical Phase I: Time duration of diagnosis and emergent treatment*
  - *Clinical Phase III: Time duration of residual functional impairment*
  - *Medical resources used for each condition*

Data integration

- **Across 4 different scenarios…**

Evidence collection- elements needed

Incidence

- Space
- Analogue
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- Condition definition
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  - % worst case

Treatment & Outcomes

- Time duration of treatment [*clinical phase II*]
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12 discrete data points (+ incidence)

Best case definition, treated

Evidence collection- elements needed

Incidence
- Space
- Analogue
- Terrestrial
- Condition definition
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  - % worst case

Treatment & Outcomes
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Best case definition, UNtreated

Evidence collection- elements needed

Incidence
- Space
- Analogue
- Terrestrial
- Condition definition
  - % best case
  - % worst case

Treatment & Outcomes
- Time duration of treatment [*clinical phase II*]
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Worst case definition, treated

Evidence collection- elements needed

Incidence
- Space
- Analogue
- Terrestrial
- Condition definition
  - % best case
  - % worst case

Treatment & Outcomes
- Time duration of treatment [*clinical phase II*]
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Worst case definition, UNtreated

Evidence collection- elements needed

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Documentation

- **Search methodologies**
- **Citations utilized to synthesize data**
  - *[via **EndNote**]*

Critical Pathway

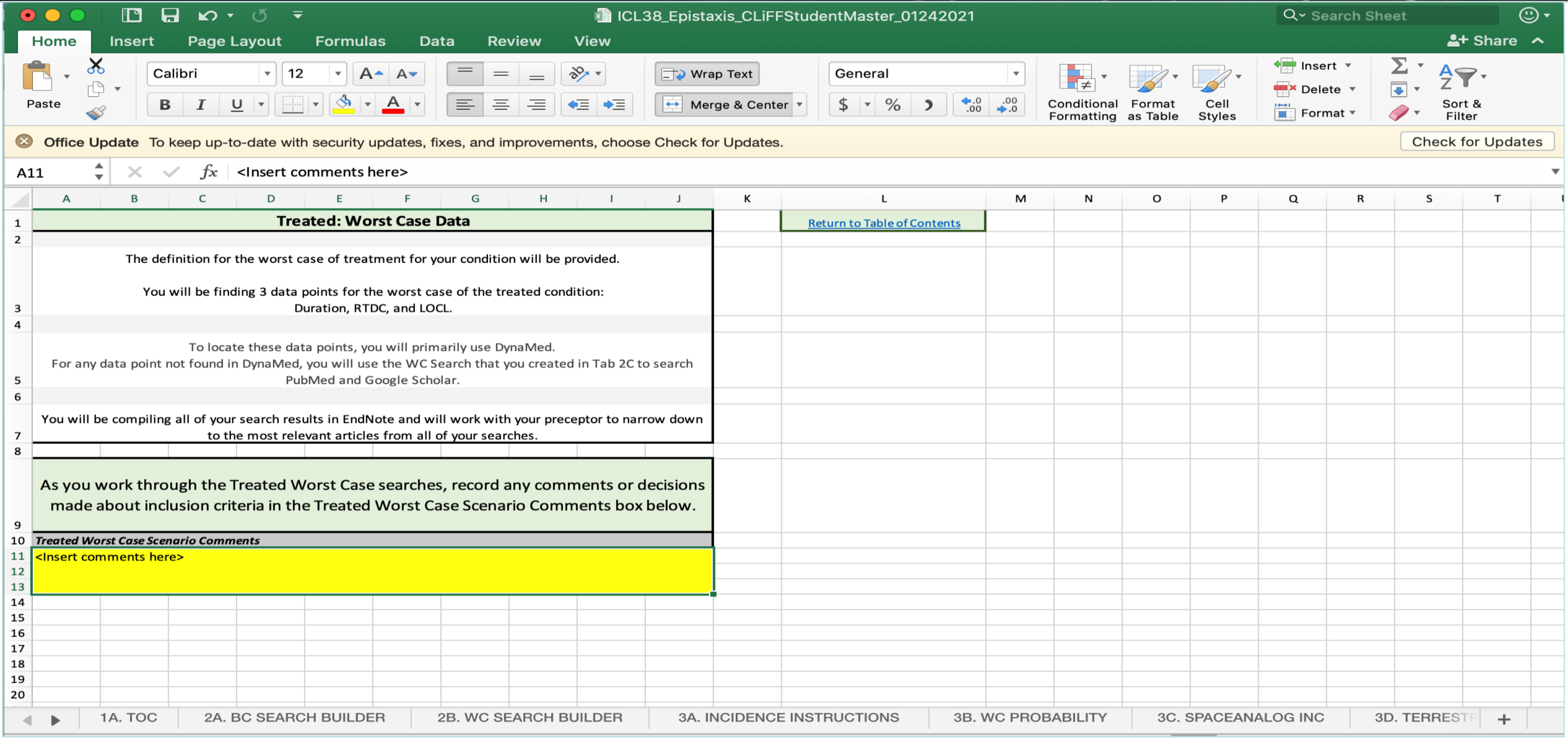
- **Students had <u>two essential and critical functions</u>:**

1. **Get the answer … or establish a range wherein the answer lives…**
2. **Conduct extensive DOCUMENT searches. *If there was in fact no answer, the student was the reason NASA thinks none exists….***

Process relied on … Transparency, Replicability, and Consistency…

When decisions are made, rationales are ultimately provided

Integrated Spreadsheet: *instructions+data*



Search Term Variations

Incidence

- Dynamed!
- PubMed
- Google Scholar
- NASA Technical Reports Server
- Barratt's textbook [via library]
- Defense Technical Info Center
- *Data from old IMM CLiFF*

Treatment/Outcomes

- Dynamed!
- PubMed
- Cochrane
- Google Scholar
- *Data from old IMM CLiFF*

Evidence grade [0-4 scale]

- ***How closely does the paper describe the medical condition that we have defined (relevance)?***
- ***How closely does the population included resemble the astronaut population?***
- ***Quality of the paper (number of subjects, methods, etc.)***
- ***How much do we trust the source of the evidence?***
- ***How closely do we think that the data represents what we will see in a spaceflight environment?***
  - *For example, in lower respiratory tract infection, we thought that terrestrial data would fairly closely model what we might encounter in spaceflight. This will obviously not be true for other conditions (such as fracture risk)*
- ***Other considerations?***

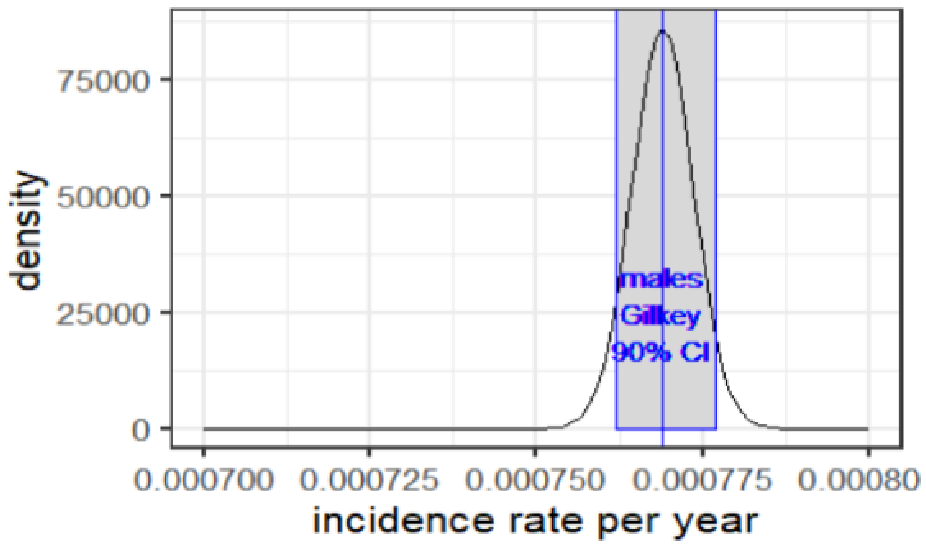
After editing, incidence data went to NASA Biostatistician to create incidence distribution

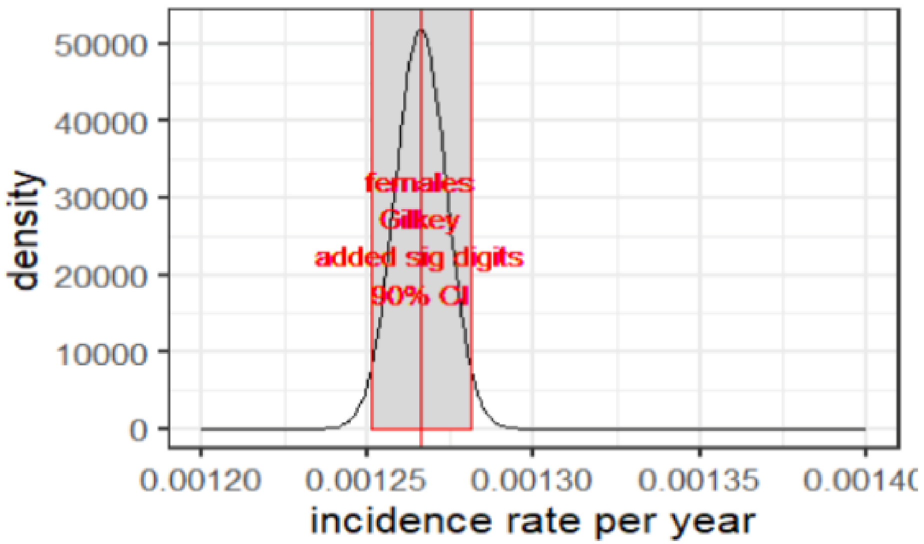
- **Guided by the clinical evidence grades**

Incidence Distribution for ICL26 Cholelithiasis – biliary colic

BLUF

From the GRC Bayesian modeling of astronaut data using terrestrial sources for informing the priors, the posterior distributions for the sex-specific incidence rates are log-normally distributed with mean 7.69E-4 and SD 4.65E-6 for males and mean 1.266E-3 and SD 7.683E-6 for females.





Assessment

- **Students had a wide range of competencies in *rapid systematic reviews* – deep logic checks reconciling their data [particularly for untreated conditions] with relevance for spaceflight was not possible given time and preceptor constraints**
  - 50% of the work happened in the first elective– before ExMC processes had been codified. *A lot of re-work done after-the-fact*
- **Not possible for CQI with individual students– gone after 1 month**
- **Steep but successful learning curve with ROI**
  - Final [3rd] elective sheets deemed 'excellent' by ExMC clinicians
- **Students given a valuable experience & exposure – many have professed a desire to continue space medicine opportunities**

Student citation
[peer reviewed, internal US Government agency]

- *YourNameHere*, Levin D., Li T., Krainin B., Abraham A., Lee-Winn A., Piper C., Hoyt A., Young M., Lemery J. "*YourMedicalCondition*: Rapid Systematic Review." *Medical Probabilistic Risk Assessment for Long Duration Spaceflight*. NASA Human Research Program, Exploration Medical Capability Element. October 2021.

Thank you